US006424923B1

(12) **United States Patent**
**Huyer et al.**

(10) **Patent No.: US 6,424,923 B1**
(45) **Date of Patent: Jul. 23, 2002**

(54) **METHOD FOR COMPUTING THREE DIMENSIONAL UNSTEADY FLOWS BY SOLUTION OF THE VORTICITY EQUATION ON A LAGRANGIAN MESH**

(75) Inventors: **Stephen A. Huyer**, Saunderstown; **John R. Grant**, Jamestown; **James S. Uhlman**, Newport, all of RI (US); **Jeffrey S. Marshall**, North Liberty, IA (US)

(73) Assignee: **The United States of America as represented by the Secretary of the Navy**, Washington, DC (US)

( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 103 days.

(21) Appl. No.: **09/675,894**

(22) Filed: **Sep. 29, 2000**

(51) **Int. Cl.**[7] ..... **G01F 1/00**
(52) **U.S. Cl.** ..... **702/45**; 703/2; 703/8; 703/9; 137/804; 73/147; 73/195
(58) **Field of Search** ..... 73/147, 195; 137/804; 703/2, 8, 9; 702/45

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,408,638 A * 4/1995 Sagawa et al. .... 703/2
5,544,524 A * 8/1996 Huyer et al. 73/147
5,600,060 A * 2/1997 Grant ..... 73/147
6,096,088 A * 8/2000 Yu et al. ... . 703/9

* cited by examiner

*Primary Examiner*—John S. Hilten
*Assistant Examiner*—Stephen J. Cherry
(74) *Attorney, Agent, or Firm*—Michael J. McGowan; James M. Kasischke; Prithvi C. Lall

(57) **ABSTRACT**

A method for computing three dimensional unsteady flows about an object. An allowable error is established for the vorticity term calculations, and object geometry is provided giving surface points on an object and a region of interest. A mesh is established incorporating points on the object. Initial flow conditions are set at the surface. Vorticity values that will satisfy boundary conditions are set at the provided surface points. A new mesh is established incorporating the provided points and other points in the region of interest. Boxes are generated containing the provided points and other points. Velocities and pressures at each point are calculated from the flow conditions, vorticity values and boundary conditions., A time variable is incremented and each point is moved by applying the calculated velocity. Vorticity at each point is then recalculated. The method is iterated starting with the step of satisfying boundary conditions until the incremented time variable exceeds a predetermined value.

**8 Claims, 4 Drawing Sheets**